Abstract No. baek584
Ag(111) Quantum Well States on Fe-Ni Alloys
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Introduction: Quantum Well States (QWS) are electronic states characteristic of multi-layer structures. Applications of QWS are well known in quantum electronics, based on semiconductor materials. In metallic multi-layers, QWS have been found to play a key role in coupling magnetic layers through non-magnetic (spacer) layers.

Methods and Materials: By spin- and angle-resolved photoemission we have studied the formation of QW states in Ag(111) ultra-thin films deposited on ferromagnetic Fe_xNi_{1-x} alloys ($o \le x \le 1$).

Results: Fe-Ni alloys grow epitaxially on a W(110) substrate for a very extensive range of concentrations. The alloy grows as bcc-FeNi(110) in the Fe-rich side ($x \ge 75\%$). For Fe concentrations $x \le 70\%$ it forms fcc-FeNi(111). A mixture of the two phases coexists in the narrow range $70 \le x \le 75\%$.
Ag grows as fcc Ag(111) on Fe_xNi_{1-x} and Ag *sp*-like QWS can be observed for all alloys compositions. As an example, in Fig. 1 are shown QWS for a Ag films grown on pure Fe(110). The effect of alloying the substrate is shown in Fig.2 On the Fe-rich side, the effect of Ni "doping" is a pronounced shift of the QW peaks toward higher binding energies. This behavior is consistent with a simple model representing the Ni doping as an upward shift of the Fermi level in the Fe bcc-band structure. The QW binding energy shift is much less pronounced on the Ni-rich side as can be expected from the considerably smaller bandwidth in Ni than Fe.

Conclusions: The energy of QW states in metallic multi-layers can be considerably shifted by doping magnetic materials. These results should have implications for the on-going research aimed at tailoring the magnetic properties of quantum devices.

References: [1] For a recent review on QW in metallic layers see: T.-C. Chiang, Surface Science Reports **38**, 181 (2000)

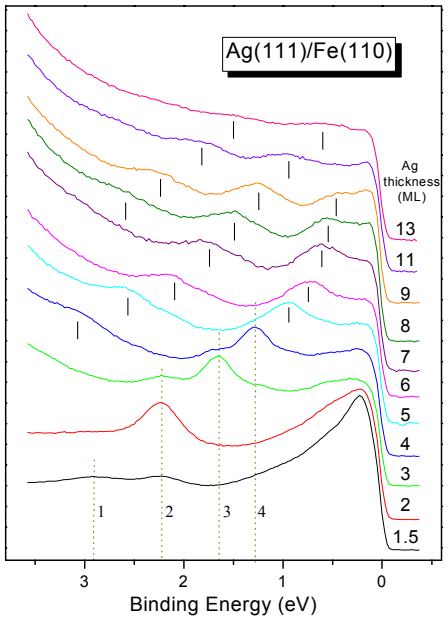

Fig. 1. Ag *sp*-like quantum wells grown on pure Fe(110) as a function of their binding energies and Ag film thickness.

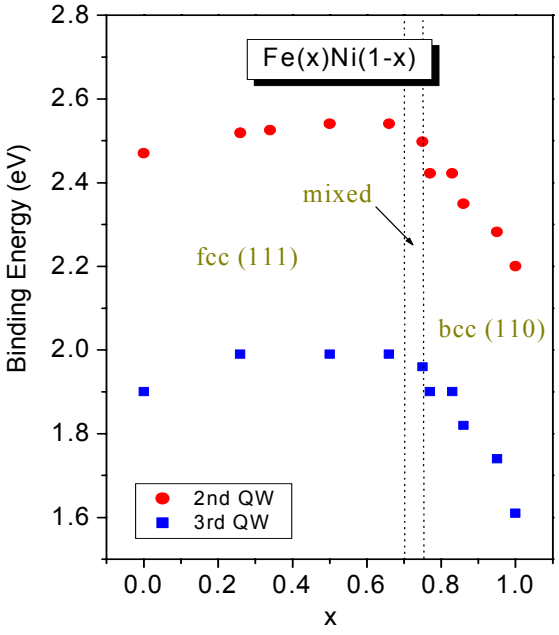

Fig. 2. Shifts of 2nd and 3rd QW states with various compositions of FeNi alloy.